

**Exhibit 11** to the Request for *Inter Partes* Re-examination of

**In re Patent No: 6,563,415**

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**Applicant: Brad A. Armstrong**

**Title: Analog Sensor(s) with Snap-Through Tactile Feedback**

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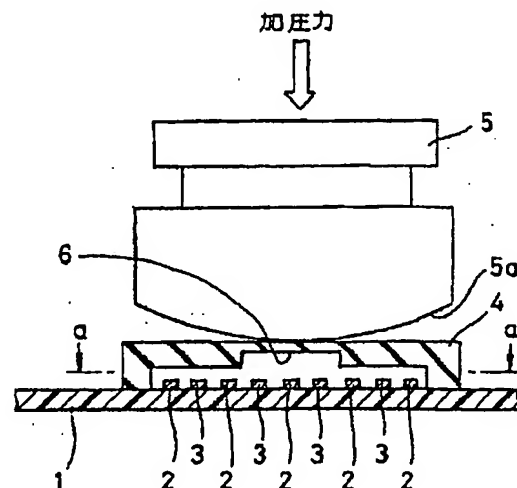
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(54)【発明の名称】 感圧スイッチ

(67)【要約】

【目的】 小さな加圧力を瞬間的に加えるだけで感圧導電ゴムの抵抗値を急激に低下させる。

【構成】 感圧導電ゴム4を断面逆凹形状に形成してつぶれやすくする。感圧導電ゴム4のつぶれ変形に伴って、電極2、3との間の接触面積が増大しつつ感圧導電ゴム4自体の通電抵抗が急激に低下する性質を利用して、電極2、3同士間のスイッチング作用を行わせる。



1 : プリント基板

2 : プラス電極

3 : マイナス電極

4 : 感圧導電ゴム

【特許請求の範囲】

【請求項1】 陽極および陰極のうち少なくとも一方の電極が設けられた基板上に感圧導電ゴムを配置してなり、この感圧導電ゴムを加圧することにより、該感圧導電ゴム自体の圧縮変形に伴う抵抗変化によって感圧導電ゴムを可動接点として一方の電極と他方の電極との間のスイッチング作用を行わせるようにした感圧スイッチであって、前記感圧導電ゴムの無加圧状態において、この感圧導電ゴムと前記一方の電極とが非接触となるように感圧導電ゴムを断面逆凹形状に形成したことを特徴とする感圧スイッチ。

【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明は、感圧導電ゴムの加圧に伴う抵抗変化を利用してスイッチング作用を行わせるようにした感圧スイッチに関する。

【0002】

【従来の技術】 感圧導電ゴムを用いた感圧スイッチとして、例えば特開昭52-5477号公報に示されているように、感圧導電ゴムにて形成された一方のシート電極の表面に多数の山形状の突起部を形成する一方、この突起部が形成されたシート電極の表面に導電布等からなる他方のシート電極を貼り合わせ、双方の電極を加圧した場合に、前記突起部の圧縮変形により両電極間の接触面積が増大するのに伴ってその通電抵抗が急激に小さくなる性質を利用して、両電極間のスイッチング作用を行わせるようにしたものが知られている。

【0003】

【発明が解決しようとする課題】 上記のような従来の感圧スイッチにおいては、ある程度まで加圧力を増大させると感圧導電ゴムの抵抗値が小さくなる傾向が認められるものの、微小な加圧力のもとでは抵抗値が無量大のままで何ら変化せず、スイッチング作用を行わせるのに必要な初期加圧力が比較的大きくなって好ましくない。

【0004】 また、従来の構造では、特定の加圧力まで加圧した場合にその抵抗値が低下したとしても、抵抗値の低下降登すなわち加圧に伴う抵抗値の低下の度合が小さくて抵抗値の低下特性が緩慢となり、その低下特性のばらつき等を考慮すると感圧スイッチとしての機能を十分に発揮させることができない。

【0005】 このようなことから、上記の抵抗値の低下特性を改善するために、前記突起部の高さを一つ置きに異ならしめた構造のものが特願平3-234523号として本出願人により提案されているが、このタイプのものでは、図4に破線Aで示すように、先のものよりも急激な抵抗値の低下特性が認められるものの、抵抗値が低下し始めてから特定の値で飽和するまでの落差の面で必ずしも十分でないばかりでなく、その落差を得るための荷重変化が比較的大きいために実用性の上でなおも課題

を残している。

【0006】 本発明は以上のような課題に着目してなされたもので、初期加圧力が小さく、しかも小さい加圧力変化のなかでより大きな抵抗値の落差が得られるようにした構造を提供しようとするものである。

【0007】

【課題を解決するための手段】 本発明は、陽極および陰極のうち少なくとも一方の電極が設けられた基板上に感圧導電ゴムを配置してなり、この感圧導電ゴムを加圧することにより、該感圧導電ゴム自体の圧縮変形に伴う抵抗変化によって感圧導電ゴムを可動接点として一方の電極と他方の電極との間のスイッチング作用を行わせるようにした感圧スイッチであって、前記感圧導電ゴムの無加圧状態において、この感圧導電ゴムと前記一方の電極とが非接触となるように感圧導電ゴムを断面逆凹形状に形成したことを特徴としている。

【0008】

【作用】 この構造によると、感圧導電ゴムを断面逆凹形状としたことによって、感圧導電ゴム自体がきわめて塊みやすくなり、感圧導電ゴムを加圧するにしたがって電極との接触面積を大きくして抵抗値を下げるとする感圧スイッチの要求特性とも合致する。したがって、電極に対する感圧導電ゴムの接触面積をより大きく確保でき、微小な加圧力でも抵抗値が急激に低下するとともに、加圧力をそれ以上増大させる必要もなくなる。

【0009】

【実施例】 図1、2は本発明の一実施例を示す図で、キーボードスイッチに適用した場合の例を示している。

【0010】 図1、2に示すように、プリント基板1上には、複数のプラス電極2とマイナス電極3とが互い違いとなるようにパター印刷により全体としてくし形状に形成されている。前記プリント基板1の上には双方の電極2、3を覆うように感圧導電ゴム4がかぶせられ、その感圧導電ゴム4の上には所定曲率の円弧状の押圧面5aを有するキートップ5が置かれている。

【0011】 そして、前記感圧導電ゴム4は、無加圧状態において電極2、3と接触することがないように全体として断面逆凹形状に形成されているとともに、その内下面の中央部には凹陥部6が形成されており、これにより感圧導電ゴム4の中央部が最も薄肉に形成されている。

【0012】 したがって、本実施例構造によれば、キートップ5を介して感圧導電ゴム4を加圧すると、図3に示すように感圧導電ゴム4が瞬時につぶれて、少なくとも複数のプラス電極2、2…のいずれかとマイナス電極3、3…のいずれかに接触する。

【0013】 そして、上記のように感圧導電ゴム4がつぶれて変形すると、プラス電極2とマイナス電極3とが感圧導電ゴム4を可動接点として単に導通するだけではなく、感圧導電ゴム4の変形に伴ってその接触面積が増

大することで感圧導電ゴム4自体の通電抵抗が瞬時のうちに急激に低下する。これにより、プラス電極2とマイナス電極3との間に必要な電流が流れてスイッチング作用が行われる。

【0014】図4の実例Bは、上記実施例における感圧導電ゴム4の抵抗値の低下特性を示したもので、無加圧状態では感圧導電ゴム4の抵抗値が無大であるのに対して、加圧するとその加圧力が30〜40gf程度の範囲内で急激に低下し、それ以上の加圧力では抵抗値の低下割合が緩慢になるものの400gf程度までは緩やかに低下し、400gf以上の加圧力では零に近い抵抗値で安定化する。

【0015】つまり、本実施例によれば、微小な加圧力を加えるだけで感圧導電ゴム4の抵抗値が急激に低下することから初期加圧力が著しく小さくて済み、しかも抵抗値が一旦低下すればそれ以上加圧力を増やすことなしにスイッチング作用に必要な十分な抵抗値の落差が得られることになる。

【0016】また、感圧導電ゴム4が断面逆凹形状であって無加圧状態では空洞状となっていることから、感圧導電ゴム4のつぶれ変形によってスイッチング作用時の節度感も得られる。

【0017】なお、上記実施例では、プリント基板1上に陽陰双方の電極2、3を配置した場合の例を示しているが、プリント基板1上には陽陰いずれか一方の電極のみを配置し、他方の電極を感圧導電ゴム4の上側もしくは感圧導電ゴム4内に配置してもよい。

【0018】

【発明の効果】以上のように本発明によれば、感圧導電ゴムを可動接点として用いてこの感圧導電ゴムの加圧に伴う抵抗変化によりスイッチング作用を行うにあたり、感圧導電ゴムを断面逆凹形状に形成したことから、感圧導電ゴムがきわめてつぶれ変形しやすいものとなり、そのつぶれ変形時の接触面積を大きく確保できるようになり、微小な加圧力を瞬間的に加えるだけで大きな抵抗値の落差が得られるとともに、一旦抵抗値が低下し始めるとそれ以上加圧力を増大させる必要もなく、感圧スイッチとしての感度もしくは応答性が大幅に向上する。

【0019】また、感圧導電ゴムの加圧時にその感圧導電ゴム自体のつぶれ変形に伴う節度感も得られることから、感圧スイッチの操作性の面でもより良好なものとなる。

#### 【図面の簡単な説明】

【図1】本発明の一実施例を示す無加圧時の断面図。

【図2】図1のa-a線に沿う断面図。

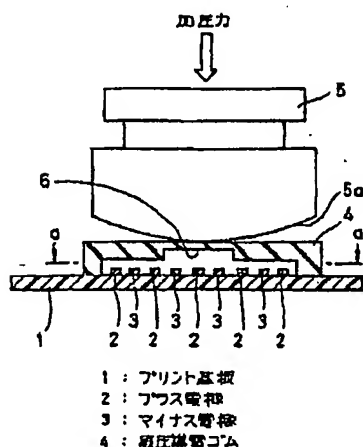
【図3】図1に示す感圧スイッチの加圧時の断面図。

【図4】上記感圧スイッチの加圧力（荷重）と抵抗値との関係を示す特性図。

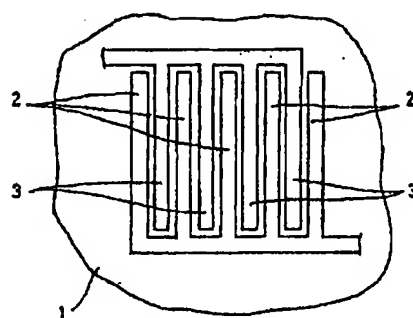
#### 【符号の説明】

- 1…プリント基板
- 2…プラス電極
- 3…マイナス電極
- 4…感圧導電ゴム
- 5…キートップ

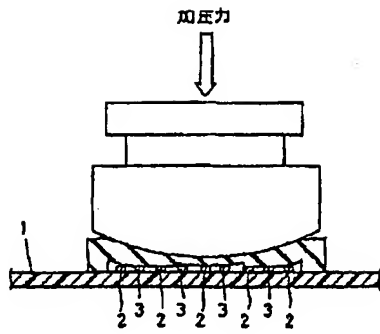
【図1】



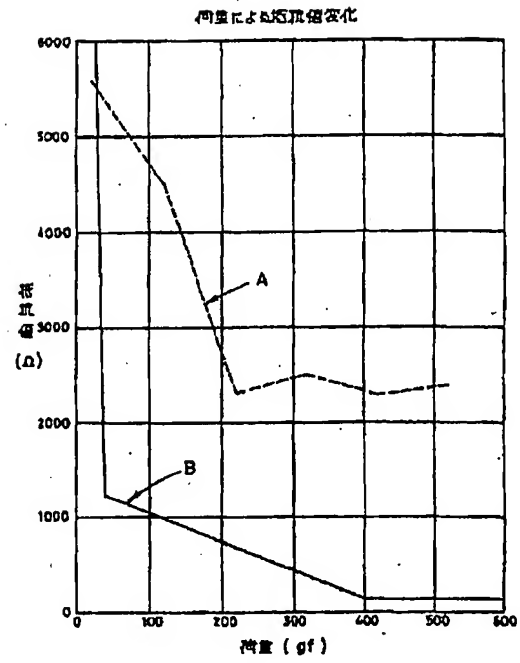
【図2】



【図3】



【図4】



## JAPANESE LAID-OPEN PATENT APPLICATION

**H5-304007 (1993)**

(19) Japan Patent Office (JP)	(11) Publication No.	H5-304007		
(12) Laid-Open Patent Application (A)	(43) Publication Date	November 16, 1993		
(51) Int. Cl. <sup>5</sup>	Identification	In-House	FI	Place of Technical
	Code	Reference No.		Designation
H 01 C 10/10		A		
H 01 H 13/12		7250-5G		
13/52		Z 4235-5G		
	No examination request			Number of claims 1 (totally 4 pages)

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(22) Date of Filing	April 28, 1992 (Heisei 4)
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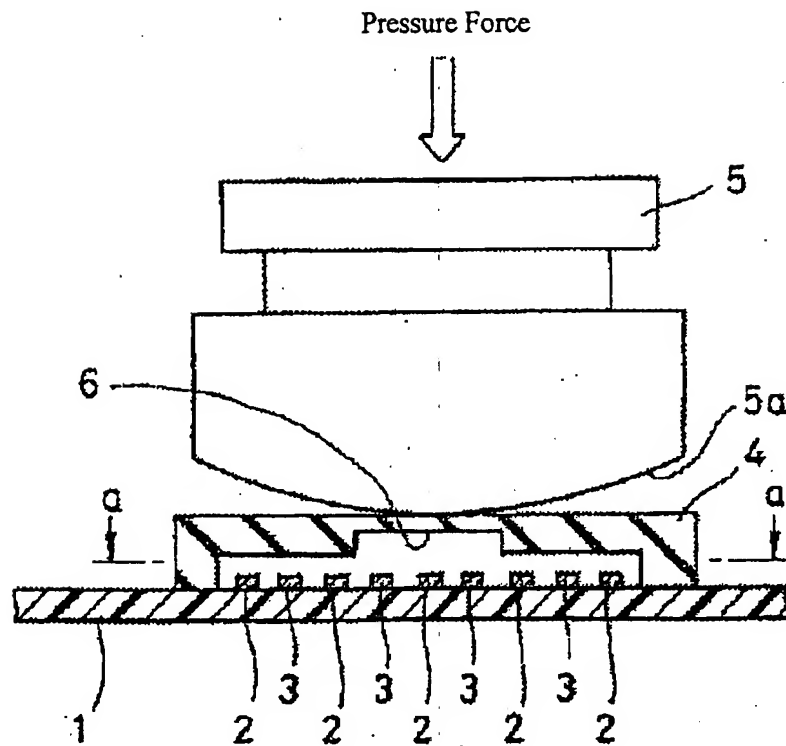
## **Specification**

**(54) [Title of the Invention]** Pressure Sensitive Switch

**(57) [Abstract]**

**[Purpose]** To suddenly lower the resistance value of pressure-sensitive conductive rubber by instantaneously applying a small pressure force.

**[Constitution]** Pressure-sensing conductive rubber 4 is formed in the cross-sectional shape of an inverted recess to make it easy to collapse. A switching operation between electrodes 2 and 3 is conducted by utilizing such a property that the electrical resistance of the pressure-sensitive conductive rubber 4 itself suddenly lowers while the contact area between the electrodes 2 and 3 increases with the collapse deformation of the pressure-sensitive conductive rubber 4.



- 1 : printing board
- 2 : positive electrode
- 3 : negative electrode
- 4 : pressure-sensitive conductive rubber

### [Claims]

[Claim 1] A pressure sensitive switch made by arranging pressure-sensitive conductive rubber on a board provided with at least one of a positive electrode and a negative electrode and accomplishes switching between one electrode and the other electrode with the pressure-sensitive conductive rubber as the center due to a resistance change accompanied by the compressive deformation of the pressure-sensitive conductive rubber itself, by pressurizing the pressure-sensitive conductive rubber and is characterized by forming the pressure-sensitive conductive rubber in the



cross-sectional shape of an inverted recess so that the pressure-sensitive conductive rubber and one electrode do not make contact in the non-pressure state of the pressure-sensitive conductive rubber.

### **[Detailed Description of the Invention]**

**[0001]**

**[Field of industrial application]** The present invention relates to a pressure sensitive switch that accomplishes switching by use of a resistance change accompanied by the applied pressure of a pressure-sensitive conductive rubber.

**[0002]**

**[Prior Art]** As a pressure sensitive switch using a pressure-sensitive conductive rubber, for example, as shown in Japanese Laid-Open Patent Application 52-5477, it has been known that many hill-like projections are formed on the surface of one sheet electrode formed by a pressure-sensitive conductive rubber while the other sheet electrode made of a conductive cloth or the like is pasted to the surface of a sheet electrode formed with these projections. When both electrodes are pressurized, switching is accomplished between the electrodes is by use of the property that their electrical resistance is suddenly lowered by increasing the contact area between the two electrodes due to the compressive deformation of the projections.

**[0003]**

**[Problem overcome by the invention]** In the conventional pressure sensitive switch described above, if the applied pressure force is increased to some extent, there is a tendency for the resistance value of the pressure-sensitive conductive rubber to reduce, but the resistance value is not changed, remaining infinite under a very small applied pressure force and the initial applied pressure force necessary for switching relatively increases, which is undesirable.

**[0004]** In the conventional structure, when it is pressurized to a specific applied pressure force, even if its resistance value lowers, dropping of the resistance value, i.e., the degree of lowering of the resistance value accompanied by the applied pressure, is reduced, the lowering characteristic of resistance value is slowed, if the dispersion of the lowering characteristic is considered, its function as a pressure sensitive switch could not be fully displayed.

**[0005]** From such a perspective, a pressure sensitive switch of a structure in which the height of the projections is allowed to be alternately different to improve the lowering of above resistance

value has been proposed by the present applicant as Japanese Patent Application H3-234523. In this type of pressure sensitive switch, as shown by the broken line A in Fig. 4, a more sudden lowering characteristic is found, but it not only is insufficient in a drop from the beginning of lowering of the resistance value to its saturation at a specific value, but also the load change required to obtain the drop is bigger, and there is still a problem of practicability.

[0006] The present invention focuses on the problems described above and provides a structure that has a small initial applied pressure force and provides a larger drop in resistance value with a small change of applied pressure force.

[0007]

[Problem resolution means] The present invention is a pressure sensitive switch which arranges pressure-sensitive conductive rubber on a board provided with at least one of a positive electrode and a negative electrode and accomplishes switching between one electrode and the other electrode with the pressure-sensitive conductive rubber as the center due to the resistance change accompanied by the compressive deformation of the pressure-sensitive conductive rubber, by pressurizing the pressure-sensitive conductive rubber, and characteristically forms the pressure-sensitive conductive rubber in the cross-sectional shape of an inverted recess so that the pressure-sensitive conductive rubber and one electrode come into non-contact in the non-pressure state of the pressure-sensitive conductive rubber.

[0008]

[Function] According to this structure, the pressure-sensitive conductive rubber is made extremely easy to flex by making the pressure-sensitive conductive rubber in the cross-sectional shape of an inverted recess, and also conforms to a required characteristic of the pressure sensitive switch that the contact area with the electrodes be increased with pressurizing the pressure-sensitive conductive rubber to lower the resistance value. Accordingly, a larger contact area of the pressure-sensitive conductive rubber for the electrodes may be ensured, the resistance value is also suddenly lowered at a very small applied pressure force, eliminating the need to further increase the applied pressure force.

[0009]

[Example] Figs. 1 and 2 are diagrams showing an example of the present invention, and show an example applied to a keyboard switch.

[0010] As shown in Figs. 1 and 2, multiple positive electrodes 2 and multiple negative electrodes 3 are formed on a print board 1 in such a shape that they are made overall different from each other by pattern printing. A pressure-sensitive conductive rubber 4 is placed on the print board 1 so as to cover both the electrodes 2 and 3; and a key top 5 having an arc-like pressing surface 5a of a prescribed curvature is placed on the pressure-sensitive conductive rubber 4.

[0011] Then, the pressure-sensitive conductive rubber 4 is entirely formed in the cross-sectional shape of an inverted recess so that it does not make contact with the electrodes 2 and 3 in a non-pressure state, a depression 6 is formed at the center of the downside thereof, and the center of pressure-sensitive conductive rubber is formed into a thinner thickness.

[0012] Therefore, according to the structure of this example, if the pressure-sensing conductive rubber 4 is pressurized via the key top 5, as shown in Fig. 3, the pressure-sensitive conductive rubber 4 collapses instantaneously, and it comes into contact with at least one of multiple positive electrodes 2, 2 ... and one of multiple negative electrodes 3, 3 ... .

[0013] If the pressure-sensitive conductive rubber 4 collapses and becomes deformed as described above, not only do the positive electrode 2 and the negative electrode 3 simply conduct with the pressure-sensitive conductive rubber 4 as a movable contact, but also the electrical resistance of the pressure-sensing conductive rubber 4 is instantly lowered by increasing the contact area with the deformation of the pressure-sensitive conductive rubber 4, a necessary current flowing between the positive electrode 2 and the negative electrode 3 to accomplish switching.

[0014] The above example A solid line B of Fig. 4 shows the lowering characteristic of resistance value of the pressure-sensitive conductive rubber 4. The resistance value of the pressure-sensitive conductive rubber 4 is infinite in the non-pressure state, and in contrast, if pressure is applied, the resistance value suddenly lowers wherein, in a range in which the applied pressure force is about 30 ~ 40 gf; the lowering degree of the resistance value slows down at a greater applied pressure force, and gently lowers until it reaches an applied pressure force of about 400 gf, and the resistance value stabilizes at a resistance value close to zero and at an applied pressure force greater than 400 gf.

[0015] According to this example, the resistance value of pressure-sensing conductive rubber 4 is suddenly lowered by applying only a very small applied pressure force, markedly reducing the initial applied pressure force. Moreover, once the resistance value is lowered, a sufficient drop of resistance value necessary for switching is obtained without further increasing the applied pressure force.

[0016] Since the pressure-sensitive conductive rubber 4 has the cross-sectional shape of an inverted recess and becomes cavity-like in the non-pressure state, a moderate feeling in the switching is obtained by the collapse deformation of the pressure-sensitive conductive rubber 4.

[0017] An example of arranging both the plus and negative electrodes 2, 3 on the print board 1 is shown in the above embodiment example, but only one of either a positive or negative electrode may be arranged on the print board 1 and the other electrode may be arranged on the upper side of or within the pressure-sensitive conductive rubber 4.

[0018]

[Efficacy of the invention] According to the present invention as described above, the pressure-sensing conductive rubber is formed in the cross-sectional shape of an inverted recess when accomplishing switching due to a resistance change accompanied by the applied pressure of the pressure-sensitive conductive rubber with the pressure-sensitive conductive rubber as a movable contact, therefore the pressure-sensitive conductive rubber is easily collapsed and deformed, ensuring a large contact area in the collapse deformation, and a large drop of resistance value is instantaneously obtained by applying only a very small applied pressure, and once the resistance value starts to lower, additional pressure force need not be applied, greatly improving the sensitivity or responsiveness as a pressure sensitive switch.

[0019] Since a moderate feeling accompanied by the collapse deformation of the pressure-sensitive conductive rubber itself is also obtained when the pressure-sensitive conductive rubber is pressurized, the pressure sensitive switch also operates satisfactorily.

**[Brief description of the drawings]**

**[Fig. 1]** Sectional view at the time of no applied pressure showing an example of the present invention.

**[Fig. 2]** Sectional view along the a-a line of Fig. 1.

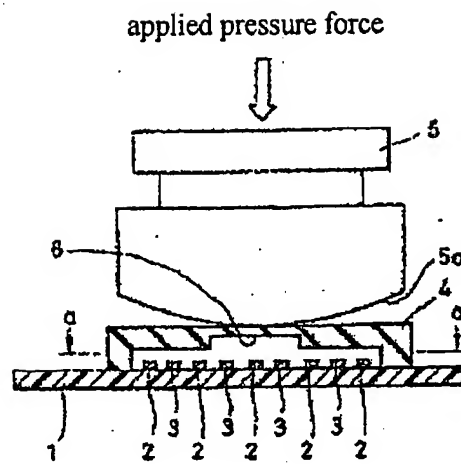
**[Fig. 3]** Sectional view of a pressure sensitive switch at the time of applied pressure showing an example of the present invention.

**[Fig. 4]** Characteristic diagram showing the relationship between the applied pressure force (load) and resistance value of the above pressure sensitive switch.

**[Description of the symbols]**

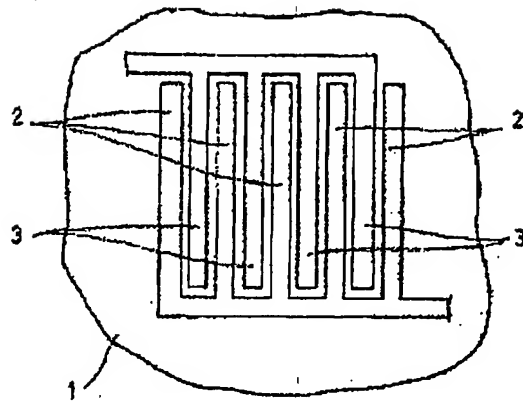
- 1: print board
- 2: positive electrode
- 3; negative electrode
- 4; pressure-sensitive conductive rubber
- 5; key top

[Fig. 1]

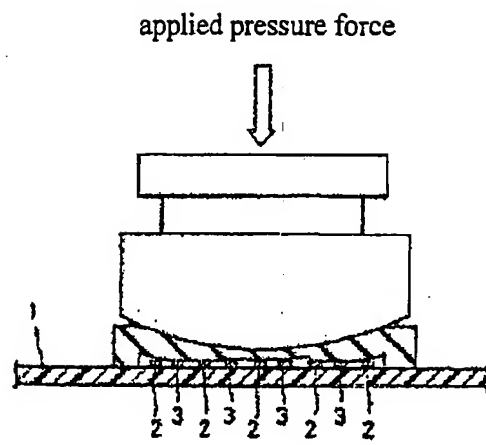


- 1: print board
- 2: positive electrode
- 3: negative electrode
- 4: pressure-sensitive conductive rubber

[Fig. 2]

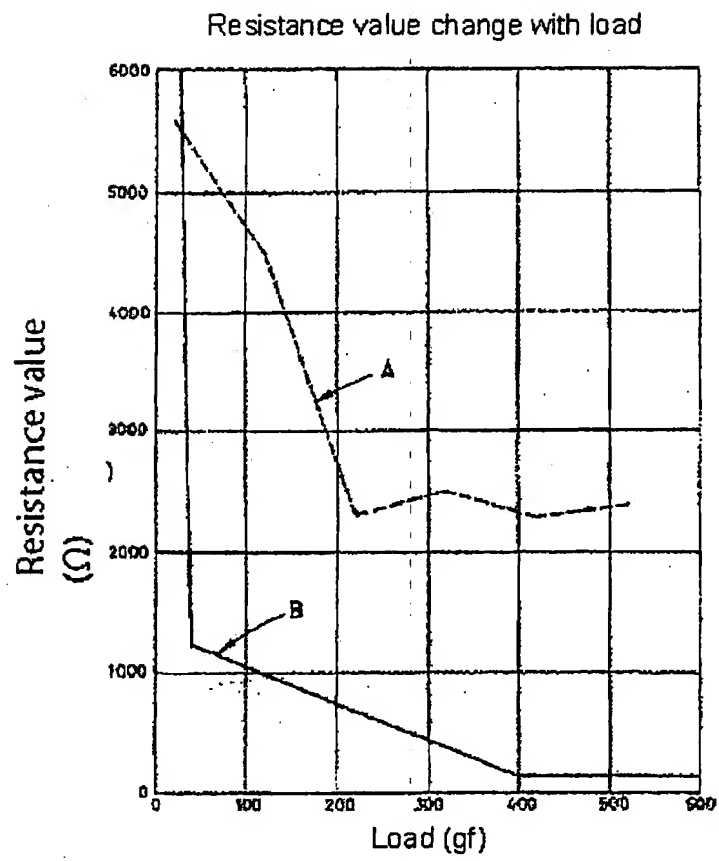


[Fig. 3]





[Fig. 4]



# CERTIFICATE OF TRANSLATION

I Roger P. Lewis, whose address is 42 Bird Street North, Martinsburg WV 25405, declare and state the following:

I am well acquainted with the English and Japanese languages and have in the past translated numerous English/Japanese documents of legal and/or technical content.

I hereby certify that the Japanese translation of the attached translation of documents identified as:


Laid Open Patent Application

H5-304007

"Pressure Sensitive Switch"

is to the best of my knowledge and ability true and accurate.

I further declare that all statements contained herein of our own knowledge, are true, that all statements of information and belief are believed to be true.



ROGER P. LEWIS

October 24, 2006

# IDS REFERENCES



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☐ FOR

**Exhibit 12** to the Request for *Inter Partes* Re-examination of

**In re Patent No: 6,563,415**

Issued: May 13, 2003

Applicant: Brad A. Armstrong

Title: Analog Sensor(s) with Snap-Through Tactile Feedback

# United States Patent

Jackson

[15] 3,643,041

[45] Feb. 15, 1972

## [54] PUSHBUTTON DIAPHRAGM SWITCH WITH IMPROVED DIMPLE ACTUATOR AND/OR CAPACITANCE-TYPE SWITCH CONTACT STRUCTURE

[72] Inventor: Charles A. Jackson, Litchfield Park, Ariz.

[73] Assignee: Unidynamics/Phoenix, Inc.

[22] Filed: Dec. 30, 1970

[21] Appl. No.: 102,803

[52] U.S. Cl. .... 200/5 A, 200/DIG. 1, 200/159 B

[51] Int. Cl. .... H01h 9/26, H01h 35/00

[58] Field of Search .... 200/1 R, 5 A, DIG. 1, 159 B

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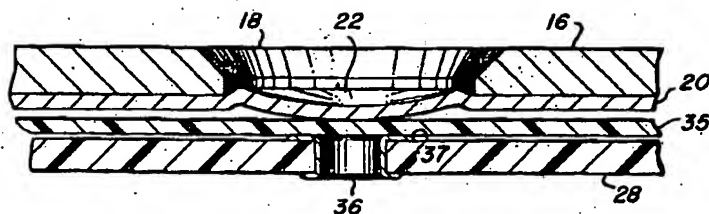
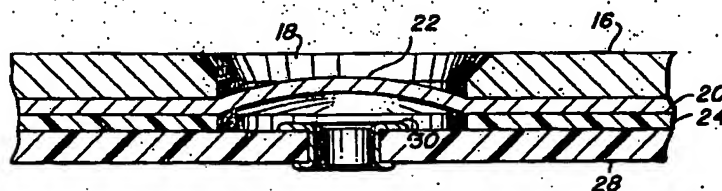
Primary Examiner—J. R. Scott

Attorney—William C. Cahill and Samuel J. Sutton, Jr.

### [57] ABSTRACT

A faceplate is provided with a plurality of openings therein, each representing a digit to be used in a keyboard; a metal switch plate is positioned immediately beneath the faceplate and includes a plurality of dome-shaped resilient deformable dimples forming keys therein, each registering with and extending into a different one of said openings. An insulating plate, with holes therein registering with the dimples, separates the switch plate from a contact board that includes a plurality of contact buttons, each registering with one of the holes in the insulating plate. The dimples may be depressed by the fingertip of an operator to "snap" into contact with a corresponding contact button and will "snap" back to their original position when fingertip pressure is released.

10 Claims, 5 Drawing Figures



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SHEET 1 OF 2

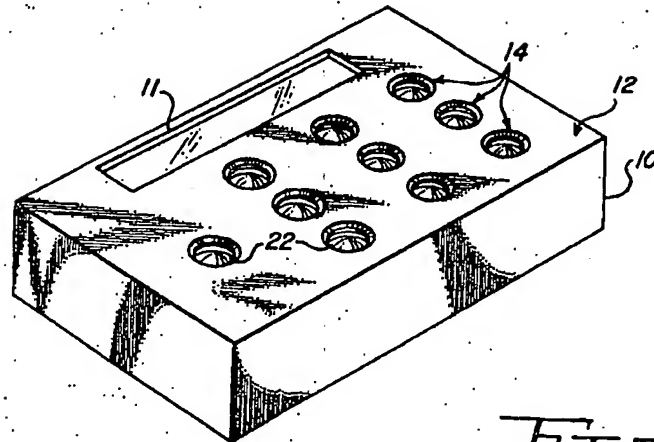


FIG. 1

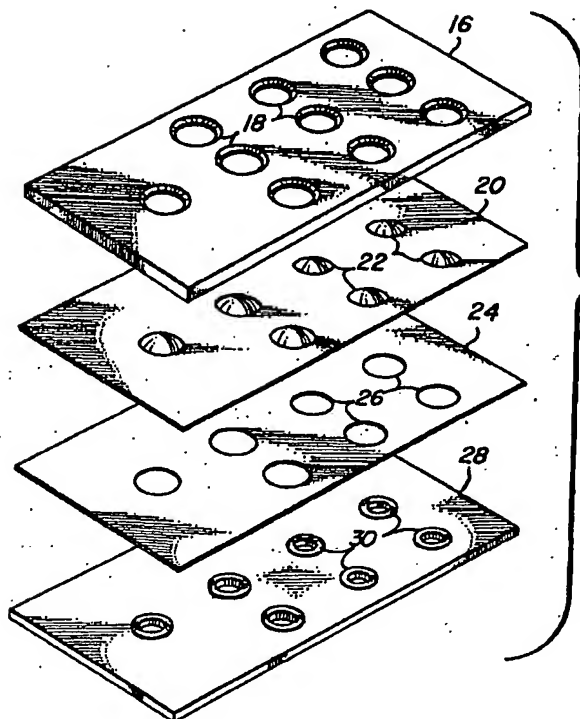


FIG. 2

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PATENTED FEB 15 1972

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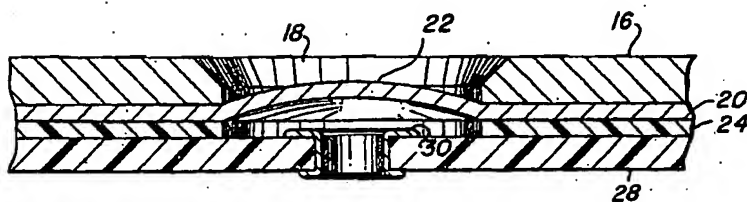


FIG. 3

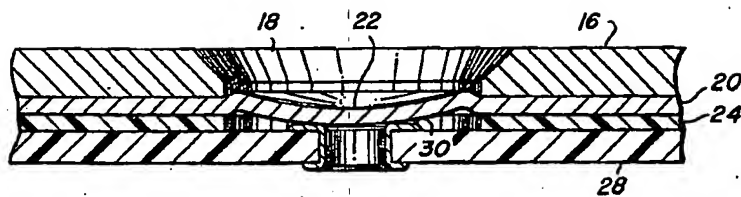


FIG. 4

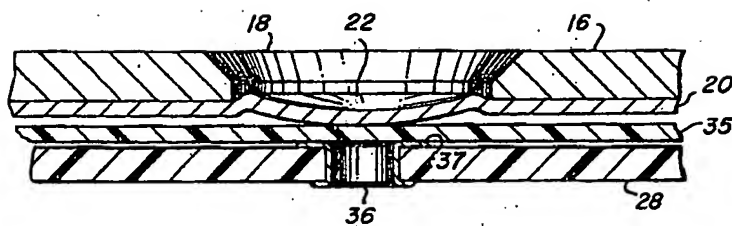


FIG. 5

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# **PUSHBUTTON DIAPHRAGM SWITCH WITH IMPROVED DIMPLE ACTUATOR AND/OR CAPACITANCE-TYPE SWITCH CONTACT STRUCTURE**

The present invention pertains to keyboards, and more particularly, to keyboard switching devices suitable for use in those instances where keyboard size is a design factor.

Miniaturization of electronic components and the introduction of integrated circuitry has enabled the reduction in size and bulk of many electrical devices; however, in numerous applications of electronic technology, there exists the requirement for a mechanical interface between the human operator and the electronic apparatus.

One such application of miniaturization is in the field of calculators wherein the heretofore bulky mechanical and electromechanical operations may now be performed by compact electronic techniques, such as integrated circuitry, etc. The requirement nevertheless exists for a mechanical interface in the form of a keyboard to permit the operator to enter the required information for subsequent calculation. The keyboard therefore becomes a critical element in determining the size of such a device. An attempt to miniaturize a keyboard has previously resulted in the incorporation of undesirable features. For example, it is desirable to incorporate a mechanical sensory feedback signal to the operator to enable the operator to determine by touch whether or not the key of the keyboard has properly been depressed. With larger keyboards and with concomitant larger displacements of mechanical keys, this touch signal is inherent in the "feel" of the keyboard; however, in reducing the size of the keyboard and the length of travel of any key in the keyboard, the sense of touch becomes critical.

It is therefore an object of the present invention to provide a keyboard that is compact.

It is also an object of the present invention to provide a keyboard incorporating a positive mechanical displacement with a minimum of bulk.

It is still another object of the present invention to provide a keyboard that can be constructed in very little space and nevertheless provide a mechanical sensory feedback signal through the fingertip of the operator.

These and other objects of the present invention will become apparent to those skilled in the art as the description thereof proceeds.

The present invention may be described by reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of a calculator incorporating the keyboard of the present invention.

FIG. 2 is an exploded view of a keyboard incorporating the teachings of the present invention.

FIG. 3 is a cross-sectional view of a portion of the keyboard of FIG. 1, showing a single key thereof.

FIG. 4 is a cross-sectional view of the key of FIG. 3, shown in a closed-circuit position.

FIG. 5 is a cross-sectional view illustrating a key of another embodiment of the present invention.

Referring now to FIG. 1, a calculator 10 is schematically illustrated in the form of a small block having a window 11 for viewing an alphanumeric display (not shown). The calculator includes a keyboard generally indicated at 12, having a plurality of keys 14 arranged in a convenient manner to be depressed by the fingertip of an operator, thus entering the required information into the calculator.

Referring now to FIG. 2, the keyboard 12 of FIG. 1 is shown in greater detail and in an exploded form. The keyboard includes a metal faceplate 16 having a plurality of openings 18 therein. A metal switch plate 20 is mounted immediately below and in contact with the cover plate 16. The switchplate 20 is formed of a continuous flat metal sheet having a plurality of dome-shaped resilient deformable dimples 22 therein. The dimples 22 are convex upward and register with and extend into corresponding openings 18. Immediately below the switchplate 20 an insulating spacer 24 is provided and may be formed of any convenient insulating material such as Mylar having a plurality of holes 26 therein. As may be seen in FIG.

2, the holes each register with a different one of the dimples 22 of the switchplate 20. Positioned below the insulating plate 24 and in contact therewith is a contact board 28 that may also be formed of any convenient insulating material, such as found in printed wiring boards. Contact buttons or rivets 30 are secured to the contact board 28 and are positioned in registration with the holes 26, dimples 22, and openings 18. The faceplate 16, switchplate 20, insulating plate 24, and contact board 28 form a "sandwich" which is extremely compact and occupies only a top thin layer of the calculator 10.

A cross-sectional view of one of the keys of FIGS. 1 and 2 is shown in FIG. 3. It may be seen by reference to FIG. 3 that the dimple 22 is convex upward and extends into the opening 18. An electrical circuit (not shown) may be connected between the switchplate 20 and any one of the contact buttons 30. The circuit selected to be energized would, of course, depend on which of the buttons 30 comes in contact with its corresponding dimple 22.

The operation of the keyboard of the present invention may be described by reference to FIGS. 3 and 4, wherein it may be seen in FIG. 3 that no electrical contact exists between the dimple 22 and the button 30. The operator's fingertip is placed in the opening 18 of the faceplate 16 and contacts the convex surface of the dimple 22. Downward pressure on the dimple will be resisted until a certain predetermined force is exerted, whereupon the dimple "collapses" with a snap action, resulting in the convex portion of the dimple becoming concave and the dimple contacting the button 30, as shown in FIG. 4. This snap action results in a mechanical sensory feedback signal through the fingertip of the operator. The sensation received by the operator is a snap sensation similar to that received when operating a toy clicker device which emits an audible clicking sound when depressed. The action of the dimple while collapsing is a modified overcenter action wherein a force on the convex portion of the dimple beyond a predetermined portion results in the collapse of the dimple but does not cause the dimple to permanently assume a convex shape; rather, immediately upon releasing the dimple, it will snap into its original shape. This snap action provides the operator with a desirable mechanical sensory feedback signal which enables him to determine that the key has properly been depressed.

The switch plate may be formed of a continuous flat metal sheet as mentioned previously; however, it has been found that good results are achieved utilizing a continuous flat plastic sheet having the bottom surface thereof metallized such as by coating with a film of aluminum.

The snap action may be achieved through a variety of switch plate and dimple dimensions. For example, it has been found that suitable action has been achieved through the utilization of a switch plate formed of a continuous flat metal sheet of stainless steel having a thickness of approximately 0.001 inch and with dimples formed therein having approximately  $\frac{1}{16}$ -inch diameter and a maximum height of approximately 0.03 inch. It has been found that these dimensions provide suitable key sizes for the average operator's fingertips, while providing excellent mechanical sensory feedback signals. Obviously, dimensional variations may be incorporated in the keyboard without departing from the spirit thereof.

The keyboard described above incorporates switches which make or break electrical contact between dimples 22 and corresponding contact buttons 30; another embodiment of the present invention is shown in FIG. 5. In FIG. 5, the faceplate 16, opening 18, switchplate 20, dimple 22, and contact board 28 are identical to those described above. In the embodiment shown in FIG. 5, however, the insulating plate 35 is a continuous flat insulating sheet without openings or holes and thus insulates the dimple 22 from the button 36. Also, the button 36 incorporates a somewhat larger upper surface 37 for reasons to be explained. When the dimple 22 is depressed as shown in FIG. 5, the capacitance existing between the button 37 and the dimple 22 is substantially greater than when the dimple is in its original position. Therefore, a circuit connected between



the button 36 and the switchplate 20 will incorporate a variable capacitance depending on the position of the dimple 22 with respect to the button 36. Conventional capacitance change sensed circuitry may be utilized to detect this change in capacitance resulting from the depression of the dimple 22, thus providing a keyboard operable through an induced change in capacitance at the selected keys.

It may therefore be seen that the keyboard of the present invention utilizes a minimum volume while nevertheless permitting a larger number of keys to be incorporated. In addition, the keyboard provides a mechanical sensory feedback signal through the fingertip of the operator while nevertheless requiring minimal key travel. The "sandwich" arrangement of the plates and spacers automatically isolates the contact buttons 30 from the atmosphere or from contamination through the openings 18 in the faceplate. The snap action of the respective dimples when contacting their corresponding contact buttons results in contact cleaning, thus assuring excellent electrical properties during the life of the keyboard. It will therefore be obvious to those skilled in the art that many modifications may be made in the embodiments chosen for illustration without departing from the spirit of the invention.

**I claim:**

1. A keyboard for effecting an electrical change upon depression of keys by the fingertips of an operator, comprising: a switchplate, having a plurality of resilient deformable dimples forming keys therein, each having a convex surface; a contact board, positioned adjacent and parallel to said switchplate, having a plurality of electrical contacts, each registering with a different one of said dimples; insulating means electrically insulating said contact board from said switchplate; each of said dimples, when depressed by an operator's fingertip depressing the convex surface thereof, contacting a corresponding one of said contacts, and when released snapping back to its original position.

2. A keyboard for effecting an electrical change upon depression of keys by the fingertips of an operator, comprising: a faceplate including a plurality of openings thereon; a switchplate, positioned parallel to said faceplate, having a plurality of resilient deformable dimples forming keys therein, each having a convex surface registering with and extending into a different one of said openings; a contact board, positioned adjacent and parallel to said switchplate, having a plurality of electrical contacts, each registering with a different one of said dimples; insulating means electrically insulating said contact board from said switchplate; each of said dimples, when depressed by an operator's fingertip depressing the convex surface thereof, contacting a corresponding one of said contacts; and when released snapping back to its original position.

3. A keyboard for effecting an electrical change upon depression of keys by the fingertip of an operator, comprising: a faceplate, including a plurality of openings therein; a metal switchplate, positioned parallel to said faceplate, having a plu-

ality of dome-shaped resilient deformable dimples forming keys therein, each having a convex surface registering with and extending into a different one of said openings; an insulating plate, positioned adjacent to and parallel to said switchplate, having a plurality of holes, each registering with a different one of said dimples; a contact board, positioned adjacent to and parallel to said insulating plate, having a plurality of electrical contacts, each registering with a different one of said holes; each of said dimples, when depressed by an operator's fingertip depressing the convex surface thereof, extending through one of said holes and contacting a corresponding one of said contacts, and when released snapping back to its original position.

4. The combination set forth in claim 2, wherein each of said keys, when depressed, transmits a mechanical sensory feedback signal in the form of a snap sensation through the fingertip of the operator to indicate that the key has been properly depressed.

5. The combination set forth in claim 2, wherein said switchplate is a continuous flat metal sheet having a plurality of dome-shaped resilient deformable dimples therein.

6. The combination set forth in claim 2, wherein said switchplate comprises a continuous sheet of plastic material having a metallized surface thereon, said metallized surface including the concave surfaces of said dimples.

7. A keyboard for effecting an electrical change upon depression of keys by the fingertips of an operator, comprising: a faceplate, including a plurality of openings therein; a switchplate positioned parallel to said faceplate, having a plurality of dome-shaped resilient deformable dimples forming keys therein, each having a convex surface registering with and extending into a different one of said openings; an insulating plate positioned adjacent and parallel to said switchplate; a contact board positioned adjacent and parallel to said insulating plate, having a plurality of electrical contacts, each registering with a different one of said dimples, a predetermined capacitance existing between each of said dimples and the corresponding electrical contact; each of said dimples, when depressed by an operator's fingertip depressing the convex surface thereof, contacting said insulating plate and changing the capacitance between the dimple and corresponding electrical contact.

8. The combination set forth in claim 7, wherein each of said keys, when depressed, transmit a mechanical sensory feedback signal in the form of a snap sensation through the fingertip of the operator to indicate that the key has been properly depressed.

9. The combination set forth in claim 7, wherein said switchplate comprises a continuous flat metal sheet having a plurality of dome-shaped resilient deformable dimples therein.

10. The combination set forth in claim 7, wherein said switchplate comprises a continuous sheet of plastic material having a metallized surface thereon, said metallized surface including the concave surfaces of said dimples.

\* \* \* \* \*